Southwest FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

Exploratory Crab Fishery to Begin in CCAMLR Waters

A permit to harvest king and stone crabs in four of the areas in Antarctic waters covered by the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) (subareas 48.1, Antarctic Peninsula; 48.2, South Orkney; 48.3, South Georgia; and 48.4, South Sandwich), was issued to an Alaskan fishing corporation active in the Bering Sea crab fishery on July 26, 1990 by the National Marine Fisheries Service. This fishing endeavor in CCAMLR waters is the first by a U.S. commercial operation and the first permitted under Department of Commerce regulations implementing the Antarctic Marine Living Resources Act of 1984. The Alaskan fishing corporation anticipates arriving in Antarctic waters in November 1990 to begin conducting this exploratory fishery using a freighter refitted with a crabpot line system, crabpots, a recovery system and a small amount of processing equipment. Other CCAMLR nations fishing in the convention area include Chile, France, the former German Democratic Republic, Japan, the Republic of Korea, Poland and the Union of Soviet Socialist Republics.

All fishing activities in convention waters, including both commercial and research, are closely monitored by member nations of CCAMLR. CCAMLR requires that catch-per-unit-effort statistics be reported by each member nation on an annual basis for all fisheries in which that nation participated during the previous year. Keeping in line with this requirement, Stephanie Sexton of the Antarctic Ecosystem Research Group (AERG) has developed logbooks to be provided to U.S. commercial vessels conducting crab fishing activities in CCAMLR waters. The logbooks request information that would thoroughly describe the fishing activities; all U.S. commercial vessels fishing within the CCAMLR fishing grounds are required to accurately complete and submit these logbooks in a timely fashion. The logs will be subsequently reviewed and analyzed by the AERG staff to provide preliminary catch-per-unit-effort statistics; these statistics will then be averaged for the U.S. fleet and submitted to CCAMLR each year. (J. Rosenberg, FTS 893-7600)

Meeting of CCAMLR Working Group on Krill in Leningrad, USSR

Rennie Holt and Roger Hewitt, along with John Bengtson of the National Marine Mammal Laboratory, attended the meeting of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) Working Group on Krill in Leningrad, USSR. The meeting took place at the International Exhibition Pavilion from August 27 to September 3.

One of the main items on the Working Group's agenda was to discuss the implications of imposing a precautionary catch limit for krill in Antarctic waters. At the last meeting of the Commission in Hobart, Australia, members were divided on the issue of setting a catch limit for krill. Some members felt that precautionary catch limits should be put into place immediately as more complete information on the role of krill in the Antarctic marine ecosystem was gathered; other members felt that available scientific evidence did not justify the setting of catch limits at this time. The working group on krill hoped its meeting would provide useful advice to the Commission, thereby allowing for a resolution of the catch limit issue at the Commission's next meeting in Hobart later this year. (J. Rosenberg, FTS 893-7600)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

COASTAL EASTERN PACIFIC POPULATION BIOLOGY OF FISHES

New NRC Postdoctoral Fellow

In August, Dr. Waldo Wakefield began a one year appointment as a NOAA National Research Council Research Associate in the Coastal Fisheries Resources Division. Wakefield received his Ph.D. from Scripps Institution of Oceanography where he studied patterns in the distribution of demersal fishes inhabiting the upper continental slope off central California. He will investigate the distribution of demersal fishes inhabiting the upper slope off the west coast of North America in relation to an array of major environmental parameters such as substrate type, topography, depth, temperature and dissolved oxygen. Trawl survey data representing a latitudinal gradient from southern California to the Gulf of Alaska will be

analyzed in an attempt to characterize the habitat for dominant members of the assemblage of upper-slope fishes. Particular emphasis will be placed on examining the distribution of upper-slope fishes in relation to the oxygen minimum layer, a major feature of the upper-slope habitat in the eastern Pacific. This work will be done in cooperation with the Alaska Fisheries Science Center's RACE Division. In addition to the aforementioned work, Wakefield will be involved in ongoing studies on age, growth, and reproduction in *Sebastolobus*, and the application of remote vehicles to fisheries science. (J. Hunter, FTS 893-7127)

COASTAL EASTERN PACIFIC FISHERIES ENVIRONMENTAL INVESTIGATIONS

Prospectus on Groundfish Oceanography Studies

A meeting was held at the La Jolla Laboratory on July 26 with Izadore Barrett, John Hunter, Mike Laurs, Bill Lenarz (Tiburon) and Gary Stauffer (AFSC) to sharpen the focus of the proposed groundfish recruitment studies, entitled "Fishery Oceanography Research and Groundfish Ecology" (FORAGE), to be conducted cooperatively between the SWFSC and AFSC. As a result of the meeting, a prospectus has been written for potential funding through the Coastal Oceans Program.

This prospectus defines the central hypothesis that variations in the timing of the "spring transition" and concomitant variations in ocean transport of late larvae and pelagic juvenile groundfishes to the continental shelf significantly impact the success of benthic settlement and recruitment of groundfish to U.S. west coast fisheries. The marked and often rapid change in oceanographic regimes known as the spring transition, occurs annually in the coastal shelf regions from central California to Washington. Because the winter and summer regimes are quite distinct, the spring transition change involves large differences in ocean conditions and currents. Although this event can be completed in a matter of a week or so, it can occur as early as February or as late as May. Spawning of most groundfish species occurs within relatively "tight" time constraints in the early months of the year. A large deviation in the timing or the strength of the spring transition, particularly the transport dynamics over the shelf, must have a large impact upon survival of planktonic life stages through either favorable or unfavorable translocations. Successful recruitment requires a timely return from the pelagic environment to the benthic nursery ground habitat.

The research program will be based on analysis of field measurements, historical analysis and modeling. Physical process studies will address the transport of early life stages of groundfish by variable ocean currents. Biological process studies will address the role of ocean circulation on stock structure and growth, and on community dynamics. Modeling activities will explore and synthesize the mechanistic relations between ocean transport and patterns in the distribution and abundance of early life stages of groundfish species determined from field studies. With the addition of historical atmospheric, oceanographic and biological time series, models will be used to test the central hypothesis and its corollaries.

In support of this prospectus, Coastal Ocean Program FY-1991 funds are being requested to conduct a pilot study to test and evaluate sampling strategies that will be employed during the full FORAGE program. The goal of the pilot study is to develop an effective experimental design and establish operational procedures and instrumentation. The pilot study is proposed for the central Oregon coast soon after the spring transition in 1991.

A workshop is also proposed in order to develop an implementation plan for FORAGE. The plan will specify research tasks and responsibilities, timelines, budgets and program management. It will also identify data products and data management responsibilities and will address the processes for extramural participation in FORAGE. (R. Lynn, FTS 893-7084)

SURVEY SYSTEMS DEVELOPMENT AND EVALUATION

Sensitivity of Life Parameters to the Population Growth of Anchovy and Sardine

Paul Smith, N. Chyan-huei Lo and John Butler started a joint project to investigate the variation of life stage duration and survival parameters related to recruitment variability of schooling coastal pelagic fishes. As a first step, Lo used a Lefkovitch stage class matrix model to examine the sensitivity of the population growth of anchovy and sardine to matrix coefficients. The matrix coefficients for each stage are the probability of survival and staying in the same stage (P_i), the probability of survival and growing into the next stage (G_i), and the reproductive output (F_i). The sensitivity index measures changes in population growth in response to the changes of the matrix coefficients. The utility of the

matrix approach is that any stage can be dealt with specifically and the effects of any stage can be evaluated in terms of recruitment variation and population biomass. It allows a balanced view of variations in population fecundity and egg, larva and juvenile growth and survival. The computations of sensitivity were mostly based on Caswell (Matrix population models 1989).

The population growth is most sensitive to G_i, followed by P_i. The population growth is least sensitive or elastic to the changes of fecundity. The sensitivity of population growth to the survival of stages is a strong beginning with late larvae (stage 4) for both sardine and anchovy (Figures 1 and 2).

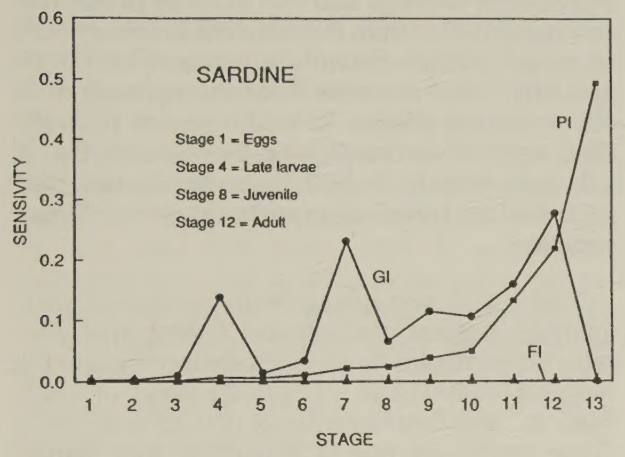

Figure 1. Sensitivity of population growth to matrix coefficients in Lefkovitch stage class matrix: P_i, G_i and F_i for sardine.

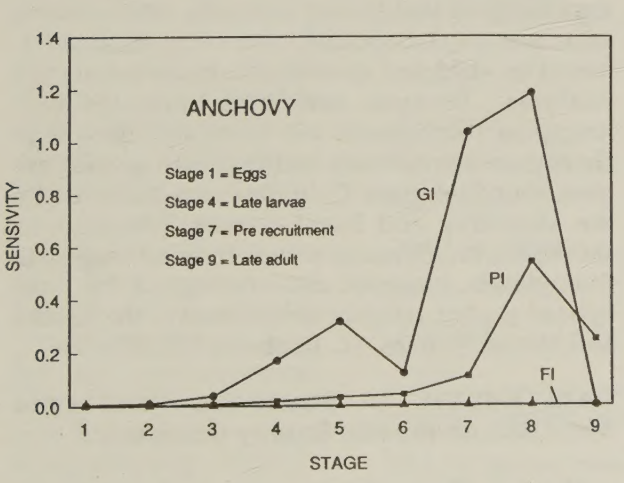

Figure 2. Sensitivity of population growth to matrix coefficients in Lefkovitch stage class matrix: P_i, G_i and F_i for anchovy.

All the matrix coefficients were computed from vital rates of anchovy and sardine, i.e. instantaneous daily mortality rate, growth rate, age-specific fecundity. The sensitivity of population growth to these parameters was also investigated. Ultimately, we will investigate the sampling error and real interannual variation for all the life stages of sardine and anchovy from the records of the CalCOFI time series. (N. Chyan-huei Lo, FTS 893-7123)

Otolith Size Separates Species of Thornyheads

Two species of thornyheads, *Sebastolobus alascanus*, and *S. altivelis* are taken in the deepwater complex of the west coast of North America. These species comprise a growing fishery for export to Japan. Little is known of the biology of these fishes, and management strategies are undefined. Age structure and growth rates of these species are now being studied by Fishery Biologist, John Butler.

This summer Butler supervised Kimberly Lu, a high school junior at Bellevue High School, Bellevue, Washington. Lu was associated with the Research Science Institute of the Center for Excellence in Education. Each summer the Center for Excellence in Education holds two national workshops for gifted students.

Each student is assigned a mentor and must carry out a research project, write a report of the project, and give an oral presentation of the results. Lu's project was to investigate the possibility of using otoliths to identify species of thornyheads. She found that for a given fish length, the otoliths of *Sebastolobus altivelis* were heavier than those of *S. alascanus* (Figure 3).

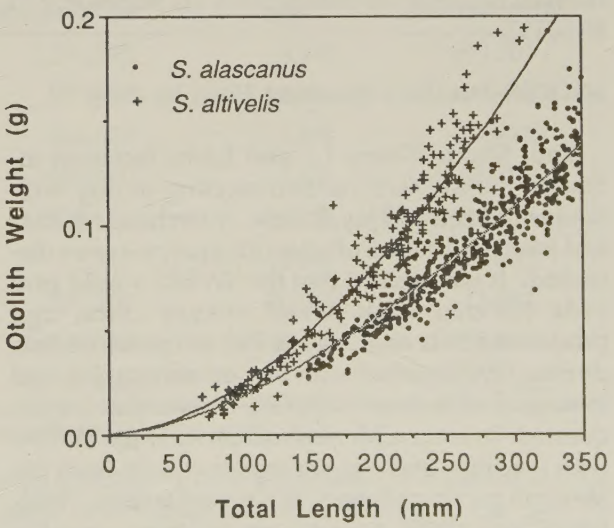

Figure 3. Total length vs. otolith weight for *Sebastolobus alascanus* (N = 220) and *S. altivelis* (N = 521).

Since identification of these two species is difficult in the field, these results make it possible to check identifications in the laboratory after otoliths have been removed for age determination. (J. Butler, FTS 893-7149)

COMMERCIAL AND RECREATIONAL FISHERIES RESEARCH FOR MANAGEMENT

Anchovy Fishery Management Plan

Larry Jacobson, Cynthia Thomson (SWFSC) and Rick Klingbeil (CDF&G) finished preparing a revised draft of Amendment 6 to the Anchovy Fisheries Management Plan. The draft has been distributed by the Pacific Fisheries Management Council (PFMC) for public comment. The new amendment includes the following revisions: 1) it allows a small reduction fishery when the estimated spawning biomass falls below 300,000 metric tons (t) (the current cutoff); 2) it includes a description of anchovy habitat and an analysis of the effects of anchovy management on vessel safety; and 3) it describes a new definition of overfishing that was adopted by PFMC at its meeting in July. The new "Two-Year Cutoff" definition of overfishing defines overfishing as harvest of any kind when the spawning biomass during the current and preceding season falls below 50,000 t. According to the proposed definition, all fisheries (reduction, live bait and other non-reduction) would be closed in the second season when the estimated spawning biomass falls below 50,000 t for two consecutive seasons. The closure would continue until the estimated spawning biomass equals or exceeds 50,000 t. (L. Jacobson, FTS 893-7117)

MEXUS-Pacifico Meeting Held in July

Paul Smith, Nancy Lo and Larry Jacobson attended the MEXUS-Pacifico meeting in July with Izadore Barrett and Jay Barlow. Interchange of data and joint publication of scientific analyses were discussed. It was agreed that the SWFSC would provide Mexico with aerial survey data, egg production data and Scripps Pier temperature data during 1990 together with any oceanographic and biological data from CalCOFI cruises that are requested. In return, Mexico will provide the SWFSC with landings and age composition data from the Mexican anchovy fishery in a timely fashion. Walterio Garcia (PESCA) and Larry Jacobson agreed to work together on the anchovy spawning biomass estimate for 1991. (L. Jacobson, FTS 893-7117)

Thornyhead Stock Assessment

Larry Jacobson has completed an assessment of shortspine thornyhead stocks in the Eureka area. A preliminary version of the assessment was discussed at the PFMC's annual meeting for 'ad hoc' review of stock assessments in Seattle, August 6-8. The completed assessment incorporates suggestions that were made at the meeting. The thornyhead market category supports an expanding fishery; coastwide landings during 1989 were almost 8,000 t and landings during 1990 are expected to be in excess of 11,000 t. Shortspine thornyhead account for the bulk of total landings (5,266 t or 66% of total landings during 1989), although the proportion of longspine thornyhead in landings has increased during recent years. Concurrent with increases in landings and real exvessel prices, real revenues (1989 $) from the thornyhead fishery have increased and are currently in excess of $6,000,000 annually. Real revenues from thornyheads have also increased relative to total revenues from the deep water Dover complex (i.e. thornyheads, Dover sole and sablefish). In 1989, thornyheads accounted for 21% of total revenues from the deep water Dover complex.

Yield and spawning biomass-per-recruit analyses suggest that optimal fishing mortality rates for shortspine thornyhead are low (F_{max} in the range of 0.038-0.12 yr^{-1}, $F_{0.1}$ in the range of 0.023-0.045 yr^{-1} and $F_{0.35}$ in the range of 0.029-0.057 yr^{-1}). These results are due to apparently low natural mortality rates (0.03-0.06 yr^{-1}) and non-asymptotic growth in weight.

Comparison of landings during 1989 with biomass estimates by bottom trawl and camera surveys suggests that fishing mortality rates in some areas may exceed optimal values (e.g. $F_{0.35}$) determined by yield and spawning biomass-per-recruit analysis. Biomass estimates indicated that longspine thornyheads are more abundant than shortspine thornyheads and that both species are most abundant in the Columbia area, followed by the Monterey and Eureka areas. Landings of shortspine thornyheads exceed those of longspine thornyheads, however, and landings of the thornyhead market category are greatest in the Eureka and Monterey areas. (L. Jacobson, FTS 893-7117)

Data Report on Southern California Sportfish Economic Survey Completed

Cynthia Thomson, industry economist, and Steve Crooke (California Department of Fish and Game) are completing their report entitled "Results of the Southern California Sportfish Economic

Survey." The target population for the survey consisted of recreational saltwater anglers residing in eight southern California counties (Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara and Ventura).

The survey data are being used to estimate aggregate effort and expenditures on fishing and to model angler behavior.

The sampling procedure involved the following: 1) a random telephone canvass of the general population in each county to identify households containing at least one person who had gone recreational saltwater fishing in the previous 12 months; and 2) a follow-up mail survey. The most active adult angler in each angling household was asked to provide information on the number and mode of fishing trips made in the previous 2 and 12 months by all household members. This same individual was asked to fill out the mail questionnaire, which asked for: 1) detailed trip information (e.g., fishing mode, target species, area fished, expenditures); 2) annual expenditures on licenses, fishing gear and boats; and 3) household demographics. The mail questionnaire also attempted to elicit information regarding the value placed by anglers on three target species (California halibut, white seabass, yellowtail) and on pier trips in general. The telephone and mail follow-up procedure was repeated with a different sample four times in 1989 (in early May, July, September and November).

A total of 2,578 angling households completed the telephone survey. Of those respondents, 2,413 expressed willingness to participate in the follow-up mail survey and 1,757 of them actually completed and returned the mail questionnaire. Both telephone and mail samples were approximately evenly distributed among counties.

The report provides almost 100 pages of tables and graphs, including county-level statistics on participation, demographics and expenditures. Some highlights of the report regarding the mail survey respondents (the most active adult angler in the 12-month fishing households) are as follows:

1) 75% are employed more than 35 hours per week; an additional 9% are retired.

2) 28% have a bachelor's degree.

3) 30% own a boat that can be used for saltwater fishing.

4) The median household income is $30,000-50,000.

5) The ethnic breakdown is 82% non-Hispanic white, 8% Hispanic, 4% Asian, 3% black and 2% other.

6) 91% are male.

7) 55% are 25-44 years of age.

8) 60% had their first saltwater fishing experience when they were younger than 13 years of age.

9) 46% subscribe to at least one magazine pertaining to fishing, hunting or other wildlife-related ac-

Table 1. Number of households, 12-month participation rate and number of 12-month fishing households by county of residence.

County of residence	No. of households[1]	Participation rate[2]	No. parties/ households[3]
Los Angeles	3,206,293	6.4%	205,203
Orange	809,938	9.8%	79,374
Riverside	360,029	6.8%	24,482
San Bernardino	456,460	5.8%	26,475
San Diego	854,152	10.0%	85,415
San Luis Obispo	78,305	12.9%	10,101
Santa Barbara	132,207	10.5%	13,882
Ventura	220,050	10.4%	22,885
Total	6,117,434		467,817

[1]Source: Western Economic Research Company, Inc.

[2]The fraction of households contacted in the telephone survey with at least one member who had gone recreational saltwater fishing in the past 12 months.

[3]Obtained by multiplying number of households by participation.

tivities (the most popular being Western Outdoor News).

10) 11% belong to at least one organization pertaining to fishing, hunting or other wildlife-related activities (the most popular being the National Rifle Association).

The 12-month household participation rate (i.e., the fraction of households containing at least one member who had fished in the previous 12 months) varied among counties. According to Table 1, it was lowest in highly urbanized Los Angeles County and the inland counties (Riverside and San Bernardino) and highest in San Luis Obispo County. Extrapolation from the sample to the population indicates that approximately 881,758 12-month fishing households reside in the 8-county survey area.

These households make approximately 4,038,283 household trips per year, 10% from beaches, 15% from piers, 43% from party/charter boats and 32% from private boats. Given that approximately 1.6 household members participate on the average household trip, these households are estimated to make 4,038,283 x 1.6 = 6,461,253 angler trips per year.

Twelve-month fishing households spend almost $800 million per year on fishing: 10% for licenses and fishing gear, 16% for boat-related expenses (maintenance, repair, insurance, etc.) and 74% for trip-related expenses (partyboat fees, private boat fuel, terminal tackle, lost wages, food, lodging, etc.).

These estimates of fishing effort and expenditures should be viewed as conservative, because they do not reflect fishing activity by households who reside outside the 8-county survey area but fish in southern California. Using a separate sampling procedure, Thomson has also obtained participation, demographic and expenditure information from a sample of non-resident fishing households. Using these data and results from the 1989 Marine Recreational Fishery Statistics Survey (which is sponsored by NMFS, Washington, D.C.), Thomson is currently attempting to estimate the non-resident contribution to fishing effort and expenditures. These estimates will also be included in the report, which will be available for general distribution in October as a Technical Memorandum. (C. Thomson, FTS 893-7116)

FISHERY-MARINE MAMMAL INTERACTIONS DIVISION

La Jolla, California

FISHERY INDEPENDENT ASSESSMENT PROGRAM

Third Annual Survey to Monitor Trends in Dolphin Abundance Begins

On July 28, two NOAA research vessels, the *David Starr Jordan* and the *McArthur*, departed San Diego to participate on a 4-month survey censusing dolphins and studying their habitat in the eastern tropical Pacific (ETP) Ocean. The Southwest Fisheries Science Center (SWFSC) is responsible for monitoring the status of stocks of dolphins which are killed incidental to tuna purse-seining activities in the ETP. This year is the fifth in a series of six research vessel surveys to monitor trends in abundance of dolphin stocks.

The first leg of this year's survey was completed as scheduled. On August 26, the *Jordan* entered port at Puerto Quetzal, Guatemala, after surveying out to 126°W and as far south as 1°N (Leg 4 for *Jordan* Figure 1). The *Jordan* was originally scheduled to survey in coastal and near coastal waters between San Diego and Guatemala (Leg 1 for *Jordan*, Figure 1); however, research clearance from Mexico was not received prior to the *Jordan's* departure from San Diego. Therefore, the only research conducted was

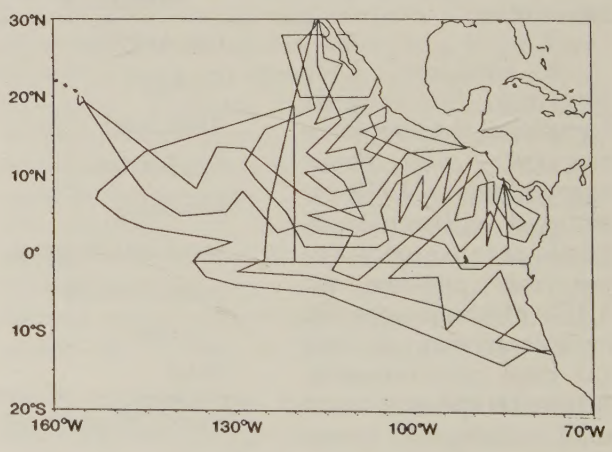

Figure 1. Monitoring of Porpoise Stocks (MOPS) 1990 tracklines for both the *McArthur* and the *Jordan* in the eastern tropical Pacific Ocean.

an aerial census of pinnipeds between July 28 through August 1 over Mexican islands off Baja (Figure 2).

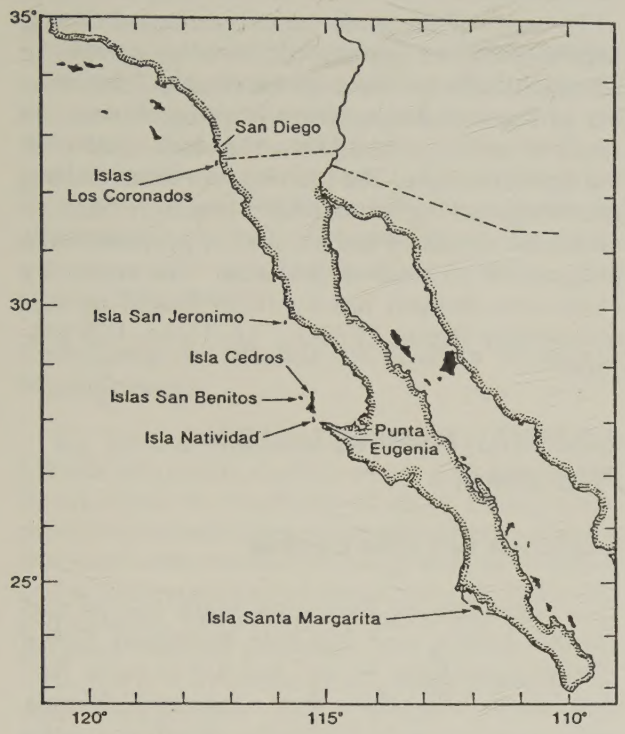

Figure 2. Islands off the coast of Baja California, Mexico, which were surveyed during the first leg of MOPS 1990.

Assuming clearance is received by the fourth leg of the survey (beginning November 7), the areas missed by the *Jordan* during the first leg will be covered during the fourth leg. This will not have a detrimental affect on the trend analyses (data are pooled over legs); however, the oceanographic studies which are time-area dependent will be impacted. The *McArthur* surveyed between San Diego and Hilo, Hawaii (Leg 1 for *McArthur*, Figure 1), where it entered port for fuel and supplies. Both vessels will depart on the second leg of this year's survey on August 31. The next inport period for both vessels is scheduled for September 29 through October 4 at Puerto Caldera, Costa Rica.

During the first leg, sighting information has been collected for 24 spotted and/or spinner dolphin schools and 21 schools of common, striped or Fraser's dolphins (the primary target species of the tuna purse-seine fishery). Information was also collected for 67 additional cetacean sightings. Observers on both vessels collected information describing birds and turtles encountered throughout the survey area. Manta tows and dip-netting (for flying fish) were conducted nightly on both vessels. Specimens collected are being stored in freezers aboard the vessels until their return to San Diego in December. Environmental and oceanographic data collection procedures continued throughout the leg on both vessels.

The Photogrammetric Remote Sensing Group (PRSG) at the SWFSC operates aboard the *Jordan* using a Hughs 500D helicopter. The primary responsibility of the PRSG is to photograph dolphin schools and use the photographs to calibrate observers' school size estimates. School size estimates are a critical component in calculating relative abundance, and calibrating observers will reduce bias in the trend analyses. For this reason also, observers will switch vessels halfway through the survey so that all observers will be calibrated. The photographs may also be used to determine the size (age) composition of a school. During the first leg of the 1990 cruise, the helicopter flew a total of 2.3 hours surveying dolphin schools, and 3.4 hours surveying pinnipeds. (T. Gerrodette, FTS 893-7131)

BIOLOGY ASSESSMENT PROGRAM

Using Bioacoustics as a Tool for Differentiating Dolphin Stocks in the Eastern Tropical Pacific Ocean

Dolphin populations subjected to incidental mortality due to purse-seine fishing by the international fleet are managed using a quota system which is set, when possible, at the stock, rather than at the species level. Three forms of spinner dolphins are recognized: 1) the coastal form, 2) the eastern form and 3) the whitebelly form. Each of these forms are morphologically distinct and are managed independently of one another as separate stocks. Common and spotted dolphins in the ETP also occur in more than one stock. Differentiation of stocks has been accomplished by examining genetic, morphological and geographical variation within the species. During the MOPS cruises, an ancillary project using bioacoustics showed promise for differentiating stocks of dolphins in the ETP.

Fishery Biologists Aleta Hohn and Scott Benson have recently written a report describing the bioacoustics project in the ETP. The MOPS cruises, designed to cover the geographic range of dolphin species taken incidentally during tuna purse-seine fishing, provided a platform for recording underwater whistles from dolphins in the ETP. During MOPS 1989, six sonobuoys were deployed to

evaluate the relative success of various methods of collecting underwater "whistles." Data, such as the type of sonobuoy, depth of hydrophone, the date, time and location of deployment and recording, environmental conditions, and characteristics of the school, were recorded. In addition, comments about the behavior and characteristics of the school or sub-school were made. A preliminary analysis of the whistles recorded during MOPS 1989 was conducted at Hubbs Marine Research Center in San Diego, California. Whistles were analyzed in real time on a UNISCAN II digital sonograph set at 20-kHz bandwidth.

Although the situations and conditions varied greatly, successful recordings were obtained from each of the six sonobuoys deployed during the MOPS 1989 survey. The quality of some of the recordings was good enough for evaluation of whistle parameters, although too few groups were recorded to begin a comparison of whistle patterns to discriminate stocks. The best recordings were from the smaller aggregations of animals located at least 3.2 km from the ship. Recordings of large numbers of animals made it difficult to distinguish individual sounds, and noise from the propeller interfered with recordings made closer than 3.2 km from the ship.

From the results to date, the optimal protocol for recording distinct whistles from individual dolphins seems to be to deploy a sonobuoy 0.8-1.6 km in front of a school of 25-30 animals when the school is 3.2-8 km from the ship, preferably off the stern (Figure 3). Sea state must be less than a low Beaufort

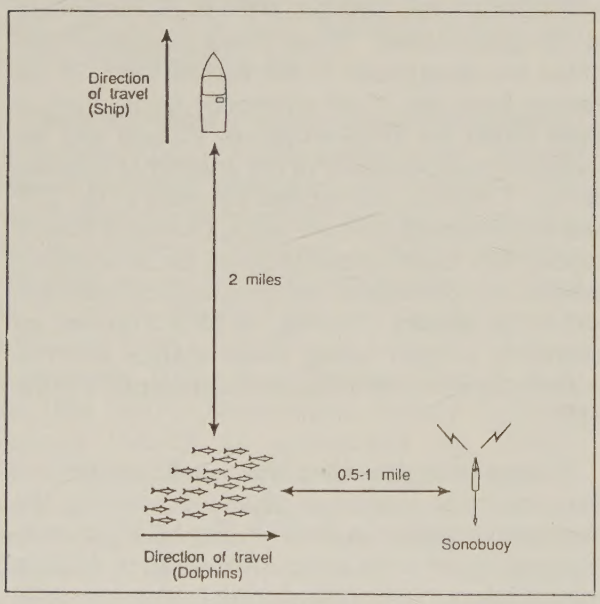

Figure 3. Optimal protocol for deploying sonobuoys.

4 and the depth of the thermocline must be greater than the depth to which the hydrophone will descend. The minimum depth of the hydrophone is 18.3 m.

For each of the three species recorded during MOPS 1989, the geographic distribution of the schools of each species were too close and the number of successful recordings from each were too small to permit us to address the stock issue with the current sample. The plan is to continue making recordings during future MOPS cruises in order to obtain the necessary sample sizes required to make judgements on stock distinctions. The report by Hohn and Benson has been published as Administrative Report LJ-90-23. (A. Hohn, FTS 893-7088)

COASTAL MARINE MAMMAL PROGRAM

California Sea Lion Census

In July, Fishery Biologists Mark Lowry and Susan Chivers, and Wildlife Biologists Robin Westlake and Joyce Sisson, traveled to Santa Barbara Island (SBI) where they censused California sea lions as part of the FMMID's continuing coastal marine mammal monitoring program. Although SBI is a small island, the steep cliffs and caves which border the sea lion rookeries make aerial photogrammetric censusing of the animals impossible to do safely and reliably. Instead, the sea lion pups of the year--the age-class providing the most reliable indicator of trend in population size--are counted with binoculars and telescopes from vantage points on the cliff tops, or by moving carefully around the perimeter of the rookery and counting at close range where access is possible. At sites where access was not possible, counts were obtained by approaching the rookery from a motorized Avon raft.

The 1990 pup count was 1,286, which is less than the 1989 count of 1,307 pups, but an increase from previous years (1,089, 917, and 814 in 1988, 1987, and 1986, respectively). Ground counts were also made at San Clemente Island (SCI) by Computer Program Analyst Charles Oliver, and Wildlife Biologist Joyce Sisson. The 1990 pup count obtained for SCI was 629 pups, which is less than previous years' counts (803, 782, 718 for 1988, 1987, and 1986, respectively). A combination of ground counts from SBI and SCI, and aerial photographic counts from San Nicolas Island (SNI) and San

Miguel Island (SMI) will be used to update the assessment of sea lion population status.

The ground counts at SBI and SCI provide the opportunity for FMMID staff to collect sea lion scats which are used by Fishery Biologist Mark Lowry to analyze sea lion feeding habits. Over 100 scats were collected during both trips to SBI and SCI. Many of the scat samples contained squid beaks, thus indicating that the sea lions were feeding predominantly on market squid. The results of the food habit analysis will be used in a long-term study of interactions between fisheries, the sea lions and environmental variations such as El Niño. (M. Lowry, FTS 893-7174)

Demographic Models in Marine Mammal Management

Jay Barlow has been working on population growth simulation models which give results that demonstrate the feasibility of using demographic models to estimate population growth rates directly from the stable distribution of age and reproductive states. Barlow examined the variance in estimating population growth rates from demographic parameters alone, independent of any information on trends in abundance. His analysis uses two common demographic models which represent opposite extremes on a spectrum from simple to complex. These models include the geometric series model and the Leslie matrix model, respectively.

The simulation consisted of randomly drawn samples from a hypothetical population of females and a record of the number in the first age class, and the number of pregnant females. Monte Carlo simulations were used to test the distribution of the variance in the estimated population growth rates. Three model life tables were used as representative examples: Example I is a generalized marine mammal with an adult survival rate of 0.9, a mean adult fecundity rate of 0.21, a survivorship from birth to sexual maturity of 5 years and a population growth rate of 1.000. Example II is the same generalized marine mammal except with a mean fecundity of 0.45 and a population growth rate of 1.065. Example III is modeled after the spotted dolphin, (*Stenella attenuata*), with age specific fecundity and survivorship, and with a population growth rate of 1.024.

Sample sizes of 500, 1000, 2000, and 4000 females were randomly drawn for each of the three sample life tables. Population growth rates were calculated from each sample, and sampling was repeated 1000 times to estimate the mean and variance of the estimated population growth rates. Table 1 gives the expected proportion of females that are in each of four age/reproductive classes (i.e., in year class 1, in other immature age classes, pregnant with female fetus, and mature but not pregnant with a female fetus) for a population in stable age distribution.

Table 1. Expected proportion of females that are in each of four age/reproductive classes for a population in stable age distribution.

Life table example	Age class one	Other immature ages	Mature and pregnant	Mature not pregnant
I	0.118	0.313	0.118	0.451
II	0.177	0.404	0.188	0.230
III	0.072	0.430	0.074	0.424

Results indicate that even under the most optimistic scenario, extremely large sample sizes are required to accurately estimate population growth rates. Even with a sample size of 4,000 females, biologically implausible high growth rates were frequently estimated. These results were based on the assumption that random sampling was the only source of error, while many other important sources of variation were ignored. If those other sources of variation were included, the situation could only be worse. It is unlikely that unbiased samples could be collected from a sufficient number of individuals in order for this approach to be useful in managing marine mammal populations, and the level of accuracy would provide little useful information for determining acceptable harvest rates.

The direct estimation of a population growth rate is not the only use of demographic models. Demographic models have already proven useful in estimating the upper limits on population growth of marine mammals. The point of Barlow's study was not to denigrate the general value of demographic data, but to emphasize that one should have realistic ideas about what can be expected of demographic models. However, seldom has the utility of demographic models for any purpose been tested before researchers go out and start collecting data. Simulation studies such as the one presented by Barlow can often reveal that a task is hopeless with any reasonable sample size, saving tremendous time and expense. Proper experimental design with a full analysis of all potential sources of error should be standard procedure before embarking on any large-scale research project. (J. Barlow, FTS 893-7178)

HONOLULU LABORATORY

Honolulu, Hawaii

FISHERIES OCEANOGRAPHY RESEARCH PROGRAM

Origin and Maintenance of Lightfish Populations at Central North Pacific Seamounts Studied

Determining the origin of recruits to populations of the lightfish *Maurolicus muelleri* at the Hancock Seamounts in the central North Pacific was the focus of research concluded recently by Fishery Biologist George Boehlert and Oceanographer Christopher Wilson, working with Keisuke Mizuno of the National Research Institute for Far Seas Fisheries in Shimizu, Japan. *Maurolicus muelleri* is a cosmopolitan sternoptychid fish most abundant near continental shelf-slope breaks. In the past, only scattered observations of this species in the open ocean have been made, but more recent studies have documented dense populations at seamounts in the South Atlantic and North Pacific. According to Honolulu Laboratory studies, *Maurolicus* is a dominant component of acoustic scattering layers evident above the Hancock Seamounts at night and most likely serves as an important prey source for many predators in the seamount ecosystem. However, the *Maurolicus* populations at the seamounts are mainly composed of juveniles. Mature fish in reproductive condition are rare and too few to support annual recruitment, which occurs at sizes greater than 20 mm standard length (SL). Furthermore, eggs or larvae are not evident in local ichthyoplankton samples. The source of the seamount populations is thus at question.

Because the largest and best known *Maurolicus* populations in the North Pacific occur around Japan, both on the Pacific coast and in the Sea of Japan, the scientists hypothesized that recruits for the Hancock Seamount populations are provided by advection of *M. muelleri* eggs and larvae in the Kuroshio extension. Mean current flow and data from satellite drifters used in other studies suggest a transit time of 100-200 days from the coast of Japan to the region of the seamounts. Although few specimens have been captured in the open ocean waters between Japan and the seamount region, net samples and whale stomach contents provide limited evidence for advection. Additionally, this may be a fairly common occurrence, based on the advection of a variety of other species-- including Japanese sardine, *Sardinops melanostictus*; chub mackerel, *Scomber japonicus*; horse mackerel, *Trachurus symmetricus*; and filefish, *Navodon modestus*--from waters around coastal Japan to the Emperor Seamount region.

Length frequencies of *M. muelleri* from the Hancock Seamounts suggest that recruitment occurs principally during the spring and summer months, with the dominant mode being 20-30 mm SL in April. Growth occurs over the summer; the largest fish (length mode, 40-50 mm SL) are present in early winter. The lack of these larger fish in spring suggests that the Hancock Seamount populations are annual. Based upon an analysis of daily growth increments (Figure 1), many of these fish are sufficiently old to have been advected from Japan, but younger fish are present as well.

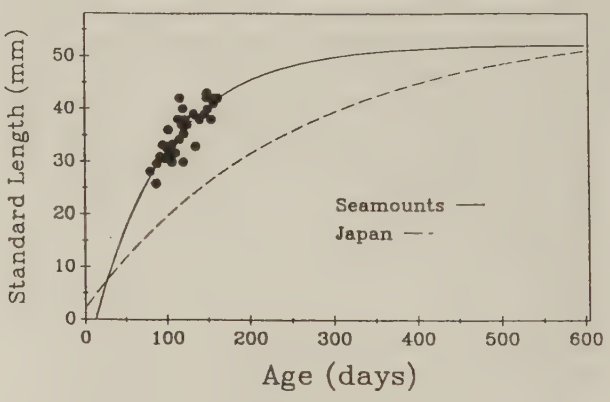

Figure 1. Age and growth of *Maurolicus muelleri* from the Southeast Hancock Seamount. Specimens were aged using daily growth increments and age-length date used to fit the von Bertalanffy relationship $L_t = 52.11(1 - \exp(-0.01093(t - 12.9)))$, where t = age in days. For comparison, the growth curve analyzed by Japanese scientists for spring-spawned fish from the Sea of Japan is indicated as a dashed line.

The growth of *M. muelleri* at the seamounts also appears to be substantially faster than that in Japan. Gill raker counts, often used to differentiate stocks in fishes, differ between Japanese and seamount populations (Figure 2). There may be an environmental component to this variation, however, due to growth rate or temperature during early development. Gill raker counts at the seamounts were identical to those from whale stomachs sampled north of the Hancock Seamounts.

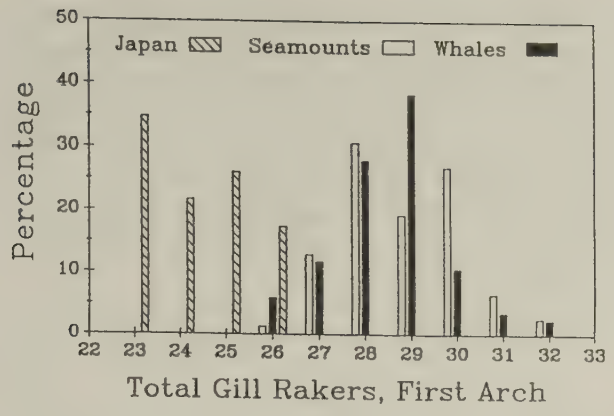

Figure 2.--Gill raker counts from *Maurolicus muelleri* from three capture locations. Specimens are from the Pacific coast of Japan (N = 28), the Southeast Hancock Seamount (N = 86) and the stomachs of sei and Bryde's whales (N = 78).

(G. Boehlert, FTS 551-3614)

Effects of Currents on Small-Scale Distribution Patterns of Seamount-Associated Micronekton Studied

The role of various biological and physical processes that may be responsible for the population maintenance of micronekton around seamounts is being investigated by Oceanographer Christopher D. Wilson. The two micronekton species being studied, the lightfish *Maurolicus muelleri* and the mysid *Gnathophausia longispina*, were identified during previous Honolulu Laboratory studies as two dominant components of the dense sound scattering layer (SSL) associated with the Southeast Hancock Seamount in the central North Pacific. These micronekton species likely serve as important prey for the pelagic and demersal fishes and squids that aggregate around seamounts in this region of the Pacific.

Both species move up into the water column above the summit at night; thus, Wilson's research is directed at determining how populations of these species respond to advective processes. For example, above certain current velocities, large numbers of either species may be transported well away from the summit and out of the seamount environment. Alternatively, animals may concentrate immediately up- or downstream of the seamount summit, or flow patterns over the summit may not produce any measurable effect in the small-scale distribution patterns of either species. To evaluate these hypotheses, Wilson is analyzing the data collected during five cruises to the seamount by the NOAA Ship *Townsend Cromwell* in 1987 and 1988.

The physical data to estimate currents over the summit were collected primarily with a 150 kHz vessel-mounted acoustic Doppler current profiler (ADCP). Absolute estimates of current velocities were determined over a depth range of 40-210 m by referencing relative current velocities to absolute ship velocities based on either bottom tracking (summit depth 260 m) or GPS navigation.

Biological data to determine the distribution of *M. muelleri* and *G. longispina* were collected with nets and acoustic instruments. Relative biomass estimates of the seamount-associated SSL based on acoustic data were determined by running 6 km long transects over the summit and flanks, which were oriented about 45° to one another in a bicycle spoke pattern. The transects began and ended about 1.9 km beyond the summit edge.

Flow patterns over the summit typically showed less variability within a cruise than between cruises. Currents during any cruise could be characterized as either predominantly unidirectional, or as anticyclonic rotations at tidal and inertial frequencies. Current speeds for any cruise rarely exceeded 30-40 cm/s. Results from the summer 1987 cruise provide an example of unidirectional currents, which were generally to the southeast or east with maximum speeds of about 40 cm/s. Velocities exhibited little vertical shear during periods of unidirectional flow (Figure 3).

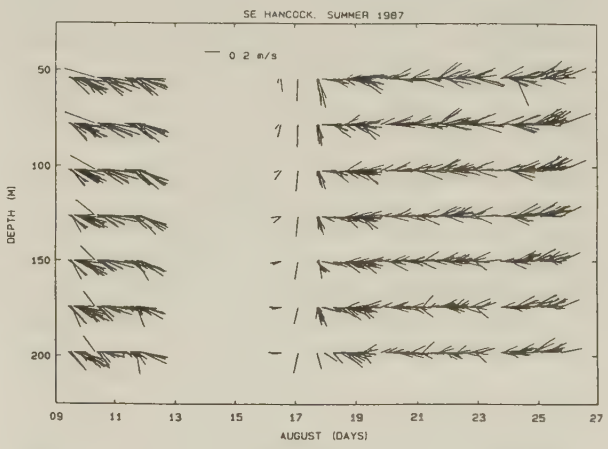

Figure 3. Current velocities from the Southeast Hancock Seamount in summer, 1987. These acoustic Doppler current profiler data were partitioned into seven depth bins of about 25 m each. North is towards the top of the figure. No data were collected during August 13-16 over the seamount summit.

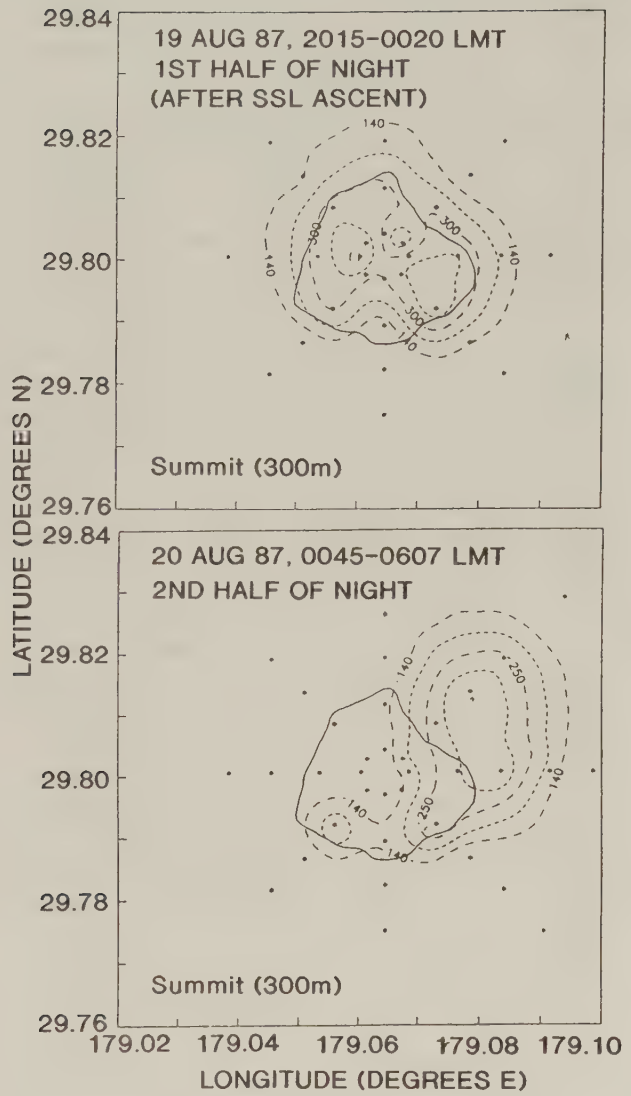

Figure 4. Relative acoustic biomass of the sound scattering layer (0-260 m) from the first and last half of one night in summer 1987. Contour values represent an arbitrary scale of relative density units. Asterisks are midpoints of areas along transects where relative densities were estimated and used as data points for contouring.

Both *M. muelleri* and *G. longispina* were displaced immediately downstream of the summit to form a dense sound scattering plume during nights when there were unidirectional currents (Figure 4). More complicated trends in the distribution patterns of both species were observed, however, on nights when anticyclonic current patterns occurred. Presently, data from cruises in which unidirectional currents were observed are being used to determine whether net displacement of the animals downstream is less than would be expected if no biological or topographically induced physical mechanisms were present. (C. Wilson (808) 943-1227)

FISHERY MANAGEMENT RESEARCH PROGRAM

Observers Aboard Hawaii Longline Vessels

Three Honolulu Laboratory technicians served as observers aboard Hawaii-based swordfish longline vessels this summer. In July, Kurt Kawamoto, fishery biologist, served as an observer aboard the *Captain Glynn* for 12 days, and Russell Ito, biological technician, served aboard the *Magic Dragon* for 24 days. In July and August, Biological Technician Robert Dollar, served as an observer aboard the *Kelly Ann* for 21 days.

Information from these trips will be compiled with other observer data to better understand the present fishing operations, the biology of the swordfish resource and potential interaction with endangered species. However, information from any individual trip, including fishing location, is kept confidential. (S. Pooley (808) 943-1216)

Results Reported for the Lobster Fishery in the Northwestern Hawaiian Islands During the First Half of 1990

Lobster fishing in the Northwestern Hawaiian Islands (NWHI) was not as strong in January-June 1990 as in 1989, reported Ray Sumida, fishery biologist, and Stacey Yoshimoto, operations research analyst. So far, six vessels have fished in 1990, making 201,000 trap-hauls (down 24% from 1989). Total landings equaled 144,000 spiny lobster, *Panulirus marginatus*, and 24,500 slipper lobster, *Scyllarides squammosus*, also down from 1989. Catch-per-unit-effort (number of lobsters per trap-haul) was down for both species compared with 1989. The only positive sign for the fleet has been the ex-vessel price of lobster, with wholesalers showing a strong demand. (S. Pooley (808) 943-1216)

Evaluation of Linear Programming Methodology

Professors Walter Miklius and Ping Sun Leung of the University of Hawaii's Department of Agricultural and Resource Economics reviewed the

linear programming approach that the Fishery Management Research Program has been using to model fishery interactions in Hawaii's commercial fishery. Their report, "Behavior Modeling in the Multi-fishery: An Evaluation of Alternative Methods," has been released as a Southwest Fisheries Science Center Administrative Report (H-90-11C).

Their report concludes that the linear programming methodology is limited in its application to the fisheries because it fails to model the behavior of fishing vessel operators. Methods for modeling fishing vessel operator behavior include: "revealed preference" methods based on previous experience in the multi-fishery, and "stated preference" methods which depend on experimental or survey techniques to elicit trade-offs between alternative fishing circumstances. Miklius and Leung outline a potential "stated preference" approach to the fishery switching problem, which might be applied through cooperation with fishery managers and fishing vessel operators.

Two University of Hawaii economics graduate students working with the Honolulu Laboratory are investigating the application of this approach to recreational and commercial fisheries situations in Hawaii. (S. Pooley (808) 943-1216)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

Study on Argentine Anchovy Completed

PFEG Chief Andrew Bakun and Fishery Biologist Richard H. Parrish have submitted a manuscript to the Journal du Conseil titled "Comparative Studies of Coastal Pelagic Fish Reproductive Habitats: The Anchovy, *Engraulis anchoita*, of the Southwestern Atlantic." The study extends the framework of comparative climatology of reproductive habitats of neritic pelagic fishes to the anchovy inhabiting the shelf-sea ecosystem off Argentina, Uruguay and southern Brazil. Maritime weather reports are summarized to yield distributions of wind stress, cloud cover, insolation, sea surface temperature, wind mixing index and Ekman transport. These distributions are considered together with other known aspects of the oceanography of the region and with seasonal and geographical aspects of reproductive activity. The comparative method is applied to diagnose the functional interactions leading to a favorable reproductive environment.

Over its extensive range, *Engraulis anchoita* makes use of three different configurations of environmental processes which affect transport, water column stability, and trophic enrichment (figures included in *Journal du Conseil* publication). Two of these are similar to configurations used by eastern ocean anchovy populations while the third has been known previously to be connecete primarily with herring. The study adds support to the idea that similar fish populations in different regions must solve similar basic environmental problems and that various experiences of environmental effects in different populations, when viewed from a properly posed conceptual framework, can add up to a useful accumulation of insight. (R. Parrish (408) 646-3311)

Impact of Climate Change on World's Fisheries

Andrew Bakun, Richard Parrish and Alec MacCall (Acting Director, Tiburon Laboratory) will be making an invited presentation at the December 3-7 American Geophysical Union's annual meeting in San Francisco. The paper will be part of the Climate Change Symposium and will emphasize the potential effects of climate change on the world's fisheries. Marine organisms, including species subject to fishery exploitation, are characterized by complex life cycles having particularly vulnerable stages wherein survival may be highly dependent on the state of the physical system. The Intergovernmental Panel on Climate Change has identified a number of potential changes in marine ecosystems that could have major effects on marine resource populations.

Enhancement of onshore-offshore sea surface temperature (SST) contrasts during the summer half of the year may be reflected in corresponding increases in alongshore winds along eastern ocean boundaries, such as the coast of California. Recent studies of environmental effects on reproductive success of coastal pelagic fishes have tended to implicate three general types of factors that act in combination to produce favorable reproductive habitat. These include: 1) enrichment of the food web via physical processes (upwelling, mixing, etc.); 2) opportunity for concentrated patch structure of food particles to accumulate (i.e., stability, lack of active turbulent mixing, and/or strong convergence in frontal structures); and 3) availability of

mechanisms promoting retention of reproductive products within the neritic habitat. All of these are substantially linked to wind intensity and pattern, but the three types of factors are mutually supportive only within special environmental configurations. Thus, greenhouse-related wind changes would be capable of rearranging the timing and geographical pattern of suitable spawning habitat, irrespective of any local temperature changes caused by direct greenhouse warming.

The Intergovernmental Panel identified a number of additional linkage mechanisms. They suggest that, due to a decrease in the large scale meridional temperature gradient, the trade wind circulation could slacken. This could lead to a reduction in oceanic upwelling and corresponding detrimental effects on oceanic tuna populations. Since the bulk of fish caught for human consumption around the world depends on estuaries or coastal marshes and swamps for part of their life cycles, substantial changes in sea level and in runoff pattern and quality would be expected to have major consequences to these populations. Increased UV-B could have a lethal effect on certain species whose vulnerable stages are concentrated at or near the sea surface. (R. Parrish (408) 646-3311)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

VAX-to-IBM PC Conversion of "CRUZTRK" Program

Programmer Analyst Ken Wallace completed the VAX-to-IBM PC conversion of the "CRUZTRK" program. This menu-driven, graphically-oriented program has been used with the VAX computer by the FMMID staff during the last 4 years to design and draw research vessel survey tracklines for monitoring trends in the abundance of dolphin stocks in the eastern tropical Pacific. The new version is designed for use on a less costly IBM-compatible microcomputer with 640K RAM, a math coprocessor and a Hercules monochrome graphics board (although some other graphics boards could be used with minor program modifications); it requires two files from the micro-TEMPLATE software package. (K. Wallace, FTS 893-7051)

1988-89 U.S. Pacific Albacore Fisheries Data Summarized

Data from the 1988-89 south Pacific and 1989 north Pacific U.S. albacore fisheries were summarized by Atilio Coan, Gary Rensink, Christina Perrin and Forrest Miller in Administrative Report LJ-90-21, titled "Summary of the 1989 North and South Pacific Albacore Fisheries Data."

The total U.S. catch for the 1989 north Pacific albacore fishery was approximately 1,600 metric tons (t), down 67% from the 4,900 t recorded for 1988, and down 89% from the 20-year (1969-1988) average of 15,000 t. The south Pacific albacore catch in 1989 was approximately 3,800 t, up 7% from the 3,500 t recorded for 1988. Estimated CPUE for north Pacific jigboats in 1989 was 27 fish-per-day, a 45% decrease from the 46 fish-per-day recorded for 1988. South Pacific jigboats caught 223 fish-per-day in 1989, an 8% decrease from the 242 fish per day caught in 1988. The average weight of albacore caught in the north Pacific increased slightly from 12.4 lbs. in 1988 to 12.6 lbs. in 1989, while in the south Pacific albacore averaged 15.0 lbs. in 1989, a slight decrease from the 15.2 lbs. average in 1988.

High catches for the 1989 north Pacific albacore fishery were centered nearshore off California, Oregon, Washington and British Columbia. The majority of albacore caught by jigboats was 60-70 cm fish. Baitboat-caught albacore were mostly from two length modal groups, 62-70 cm and 72-90 cm, as compared to a single modal group of 59-66 cm in 1988. Fewer large (85 cm) fish were caught compared to 1988. High catches in the south Pacific were centered in an area 35° to 39° south and 138° to 161° east.

Sampling coverage of logbooks for the U.S. north Pacific fishery was 42% in 1989, compared to 32% coverage in 1988, while length-frequency data coverage in 1989 was 4%, up from 3% for 1988. In the south Pacific fishery, logbook coverage increased from 21% in 1988 to 42% in 1989, and length-frequency data coverage increased from 1% to 3%. (A. Coan, Jr., FTS 893-7079; G. Rensink FTS 893-7192)

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

High Seas Driftnet Assessment Program

The interaction between the high seas driftnet fisheries and the U.S. albacore troll fishery is an

important factor in assessing the north Pacific albacore stock. U.S. albacore fishermen are cooperating with the SWFSC in a study to assess this interaction. Observers are aboard a sample of U.S. vessels to quantify the incidence of gillnet-damaged albacore in the catch. Three observed fishing trips, totaling 202 sea days, were completed in August; three more trips are still at sea, two departed in July and one in September. Additional trips are scheduled through the end of the fishing season.

Two observed U.S. vessels fishing north and west of Hawaii in June and out to the international date line reported no catches, but observed several driftnet vessels operating in that area. They proceeded eastward in July fishing along the Transition Zone where catches were good—200 to 400 albacore per day at 40°N and 155°W. Approximately 20 percent of the fish caught had marks from large mesh gillnets. The vessels completed their trips in August off the north end of Vancouver Island where the incidence of marked fish was 4 to 5 percent.

The F/V *Kismet*, with observer Sam Modugno aboard, departed San Diego in July on charter to the American Fisherman's Research Foundation. It fished off the coast of Oregon and Washington where fishing was poor, with fish in the 7 to 20 pound range. Most of the large fish caught had net marks. Moving north to 50°N and 127°W, fishing improved, with up to 95 percent of the catch showing signs of damage from high seas squid nets. The *Kismet* returned to port in August.

The F/V *Pursuit* departed Honolulu July 21 with Biological Technician John Childers aboard. It proceeded north and east of Hawaii reporting meager catches in the North Pacific Transition Zone. The F/V *Nightwind*, with Biological Technician Ed Fisher aboard, departed Bodega Bay, California on July 19. Both vessels are currently fishing along the west coast and reporting catches of 100 fish per day (16-18 lbs. each), with only a few fish showing net marks.

Biological Technician Greg Yee boarded the F/V *Royal Dawn* in September in Astoria, Oregon and headed northward to the fishing area.

Albacore drop-out experiment.--Negotiations were completed for use of a wave tank to conduct an albacore dropout experiment. ARCTEC, an Escondido, California firm, will provide the facility to conduct the experiment. ARCTEC's wave and towing basin can produce a Beaufort 4 sea state with mechanically generated waves. A section of gillnet will be deployed in the tank. Dead albacore will then be placed in the experimental gillnet and be subjected to a series of sea states to observe drop out rates. (D. Holts, FTS 893-7186)

34th Annual Hawaiian International Billfish Tournament Held

Jim Squire participated in the briefing events for the 34th Annual Hawaiian International Billfish Tournament in Kailua-Kona, Hawaii in mid-August. The briefing, which was for participants of the 59 fishing teams from throughout the world, included a review of the results of billfish tagging off Baja California, Mexico. At a reception preceding the tournament, Squire presented the 1989 Hawaiian Billfish Tagging Award to Captain Bobby Brown of the charter boat *No Problem*. The award is given by the Pacific Ocean Research Foundation (formerly the Pacific Gamefish Research Foundation) to the captain who tags and releases the most billfish during the year. Captain Brown started tagging marlin off Kona in 1976, and in 1989 tagged and released 62 billfish. (J. Squire, FTS 893-7072)

PELAGIC ECOSYSTEM DEVELOPMENT PROGRAM

Diffusive and Advective Population Models

Operations Research Analyst Carlos Salvadó and Fishery Biologist Pierre Kleiber are using diffusive and advective equations to simulate migration in conventional population models. If N is the population density, its dynamics in space and time are defined in the modified model as,

$$\frac{\partial N}{\partial t} = F(N) - c \cdot \nabla N + K \nabla^2 N$$

where c is the advective velocity, and K the diffusion coefficient.

A computer program that incorporates this concept with variable advective velocity, diffusive rate and the coefficients in the growth model F(N), in one temporal and two spatial dimensions, is being developed. The computer program will define the various coefficients as functions of the population density itself, using the boundary integral equation (BIE) techniques.

A typical user will define boundaries and provide boundary and initial conditions as input. The minimum output is the size of the population density at one space-time point. The advantage, however, that the BIE method has over finite difference

technique, is that the user can obtain density time series for arbitrary points in space.

The computer model is being formulated for use in tuna assessment analysis. Because data from tuna fisheries are often imprecise, the computer model is being developed for low numerical accuracy, but faithful qualitative behavior. This means that since the space-time steps can be large, computation can be faster. (C. Salvadó, FTS 893-7052; P. Kleiber, FTS 893-7076)

TIBURON LABORATORY

Tiburon, California

Southern California Biostatistical Contaminant Study is Completed

A biostatistical study of contaminant effects on southern California fish stocks was initiated by Alec MacCall and Michael Prager (on IPA loan from Old Dominion University) at the La Jolla Laboratory in 1985, with funding supplied by the Seattle Office of the Ocean Assessments Division, NOS. The study was still underway when MacCall transferred to the Tiburon Laboratory.

The study explored biostatistical approaches to identifying effects of contaminants on biological populations. Two approaches to the determination of environmental factors associated with recruitment success were applied to several southern California fishes. The first, the "biomass-based" method, is a nonlinear time series analysis of abundance indexes derived from either CalCOFI surveys (northern anchovy, Pacific sardine, Pacific whiting) or landings histories (California halibut). The second method is multiple linear regression, using a transformed Ricker stock-recruitment model and age composition-based estimates of spawning biomass and recruitment (northern anchovy, Pacific sardine, Pacific mackerel). Explanatory variates consist of principal components of a time series of contaminant and natural environmental variables.

Results of the two approaches are in good agreement for the Pacific sardine, but results for the northern anchovy are inconsistent. Pacific sardine and California halibut show positive responses to year-long warm sea surface temperatures and elevated sea levels. Pacific mackerel also respond positively to these conditions, but only early in the year; upwelling is favorable later in the year. Results for northern anchovy and Pacific whiting are unreliable. Contaminant effects are not discernable in any of these analyses, but the statistical analyses lack the power to conclude that such effects are not present. (Alec MacCall, FTS 556-0565)

GROUNDFISH ANALYSIS INVESTIGATION

Groundfish Stock Assessment Reports Completed

Widow rockfish.--Joseph Hightower and William Lenarz, fishery biologists, have completed a report on "Status of the Widow Rockfish Fishery in 1990" for the Pacific Fishery Management Council (PFMC). The stock synthesis model was used to analyze 1979-1990 landings estimates and 1980-1989 age composition data. For the three levels of 1989 fishing mortality (F) considered most likely, estimates of 1991 biomass ranged from 41,200 to 81,300 metric tons (t). Two recently recruited year classes (1982, 1983) are relatively weak, and these year classes contributed to recent declines in abundance. Projected 1991 landings at the recommended fishing mortality rate ranged from 3,400 to 7,100 t, depending on the assumed F for 1989. The recommended 1991 acceptable biological catch (ABC) was 7,000 t, which is 11% less than the 1990 ABC recommended in the previous assessment. Higher landings would significantly increase the probability that the spawning stock would drop below 20% of the unfished level. Reliable auxiliary data are needed in order to reduce the uncertainty in the abundance estimates and ABC's. (J. Hightower, FTS 556-0565)

California rockfish complex.--Donald Pearson and Stephen Ralston, fishery biologists, have completed a NOAA Technical Memorandum titled "Trends in Landings, Species Composition, Length-frequency Distributions, and Sex Ratios of 11 Rockfish Species (genus *Sebastes*) from Central and Northern California Ports (1978- 88)" (NOAA-TM-NMFS-SWFC-145). A brief summary version was provided to the PFMC for inclusion in the Council's 1990 status of stocks document. The report documents changes in the species composition of California trawl landings over time. For example, widow rockfish and bocaccio constitute a smaller proportion of total landings than during 1978-1982, whereas chilipepper and dark-blotched rockfish have increased in importance. Most of the 11 *Sebastes* species examined have shown a reduction in

mean length during the 11-year study period, with yellowtail and canary rockfish and female chilipepper showing the sharpest declines.

Stephen Ralston, Alec MacCall and Donald Pearson also completed a report for the PFMC titled "Reduction in Mean Length and Exploitation of Central and Northern California Rockfish." This report will also be included in the Council's 1990 status of stocks document. It provides some simple models for estimating the level of historical fishing mortality that would be needed to produce the observed changes in mean length. The results suggest that many California rockfish species are subjected to substantial fishing pressure. Of particular concern are male bank, dark-blotched and splitnose rockfish; both sexes of widow, yellowtail and canary rockfish; and female chilipepper. With the exception of widow rockfish, no overall limit exists on the annual catch of these species. Additional assessments are strongly recommended to more accurately determine the condition of these stocks. (D. Pearson and S. Ralston, FTS 556-0565)

Bocaccio.--James Bence, mathematical statistician, and Joseph Hightower have submitted a report to the PFMC titled "Status of Bocaccio in the Conception/Monterey/Eureka Areas in 1990." The stock synthesis model was used to analyze 1978-1989 landings estimates; 1978-1984 trawl age composition data; and 1978-1989 trawl, 1986-1988 setnet, and 1980-1989 recreational length composition data. Estimates of fishing effort were available for the recreational fishery, and the NMFS triennial trawl survey provided catch-per-unit-effort estimates and length composition data for 1980, 1983, 1986 and 1989.

Landings peaked in 1982-1983, due in part to the strength of the 1977 year class. For the two levels of 1989 trawl F's considered most likely, biomass was estimated to have declined from 69-77 thousand t in 1978 to 7-14 thousand t in 1990. The steep decline in abundance apparently is due both to significant fishing pressure and poor recent recruitment. Year classes prior to 1978 were substantially larger on the average than more recent year classes. Projected 1991 landings at the recommended fishing mortality rate ranged from 800 to 1,700 t, depending on the assumed F for 1989. (J. Bence, FTS 556-0565)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Fecundities of Yellowtail Rockfish from Washington State Determined

Fecundity estimates for Washington state yellowtail rockfish (*Sebastes flavidus*) were completed for the second consecutive year of a comparative study. Washington fish were selected as examples of yellowtail rockfish in the center of their geographic range. Individual and population life history traits for Washington fish are being contrasted with those for fish collected from Cordell Bank, California.

A comparison of 1988/89 with 1989/90 samples shows that the 89/90 fish were slightly older, longer and heavier (Table 1).

Table 1. Sample sizes, means and standard deviations of selected variables measured in female yellowtail rockfish from Washington state during the 1988/89 and 1989/90 reproductive seasons.

Variable	1988/1989	1989/1990
n	130	86
Age	11.6±3.1	12.7±2.5
Wet weight (g)	1813+464	1893+357
SL(cm)	40.8+3.6	41.6+2.6
Gonad weight (g)	117.7+103.2	138.8+129.5
Fecundity (eggs/female)	1,019,365+420,361	831,407+285,290

Table 2. Linear regressions of fecundity (F) on total wet weight (W), standard length (L) and age (T) for yellowtail rockfish from Washington state for 1988/89 and 1989/90.

Variable		Equation	Correlation coefficient
Wet wgt. (g)	88/89	F = -489767.1+764.8113W	0.80
	89/90	F = 288711.4+268.2002W	0.28
SL (cm)	88/89	F = -3305395+103482.4L	0.75
	89/90	F = -913033.9+41177.79L	0.31
Age (yr)	88/89	F = -21891.89+86118.96T	0.64
	89/90	F = 480698+26495.9T	0.25

Mean fecundities of these 1989/90 fish were lower but differences were not significant (t-test, $P<0.05$). This was probably due to the wide range of values found in the 89/90 fish. Variability of fecundities in 89/90 samples accounted for the low correlation coefficients (Table 2).

Regression equations showed a reduction in fecundities of older, heavier and longer females. Further analyses are planned to assess the extent of these reductions and their possible explanation. The condition of Washington yellowtail rockfish from both years was good, especially when compared to the poorer condition of Cordell fish. Disease states, incidences of parasites and pathologies were lower than in California fish. In addition, the amount of mesenteric fat was consistently higher in Washington fish. (M. Eldridge, FTS 556-0565)

Initial Data on the Physiological Condition of the 1990 Young-of-the-Year Yellowtail Rockfish

In 1989, the Groundfish Physiological Ecology Investigation initiated a project to determine the health, or nutritional and physiological conditions, of juvenile yellowtail rockfish from Cordell Bank and surrounding areas. The objectives of this research include: 1) to determine the year-to-year variability in health in relation to significant environmental factors; and 2) to determine the relationship between juvenile condition and maternal condition variables from the previous reproductive cycle.

The evaluation includes measurement of morphometrics, lipid concentrations and lipid class analysis, calorimetry, nucleic acid ratios, protein content and extent of abnormalities. Currently, morphometric data and nucleic acids concentrations are available. Results to date indicate that, relative to the 1989 young-of-the-year (YOY), the abundance of 1990 YOY yellowtail rockfish is lower and the growth rates are diminished (Table 3).

Although the ages of the 1990 YOY specimens are not yet available, 1990 YOY samples were obtained during the same time interval (late May and early June) as were the ones evaluated during 1989. Further support for the contention that the ages of juveniles evaluated between years is similar, is that, typical for this species in this area, parturition occurred during February and March in both 1989 and 1990. If the age distribution is similar for specimens collected for the two years, then the 1990 year-class growth rates are reduced both in the long-term and recent past, from the dates of collection. Long-term reduction in growth is evident from shorter length, and particularly, from lower weight.

Table 3. Data from juvenile yellowtail rockfish (*Sebastes flavidus*) collected from the Gulf of the Farallones and Cordell Bank during the May-June cruises in 1989 and 1990. Values are means ± SD; N in parentheses.

Variable	1989	1990
Length (mm)	39.0 ± 4.1 (50)	34.3 ± 3.7 (24)
Weight (g)	1.06 ± 0.30 (49)	0.64 ± 0.20 (24)
Age (d)	94.4 ± 9.4 (49)	
RNA (mg/g)	2.65 ± 0.55 (21)	4.35 ± 0.81 (8)
DNA (mg/g)	0.26 ± 0.05 (21)	0.53 ± 0.12 (8)
NA/DNA	10.6 ± 1.7 (21)	8.2 ± 1.0 (8)

Recent growth can be estimated from the ratio of ribonucleic acid to deoxyribonucleic acid (RNA/DNA) in tissues. Since the DNA content per cell is constant within a species, and RNA concentrations increase during protein synthesis, the RNA/DNA provides an index of protein synthetic rate, and therefore, growth rate. The RNA/DNA has been shown to vary with age. Generally, ratios are greatest during early stages and decrease as organisms, including fish, get older. The utility of the RNA/DNA parameter lies in its responsiveness to recent feeding history. Laboratory studies have demonstrated the relationship between food and larval fish RNA/DNA. The greater the RNA/DNA, the greater the protein synthesis, and thus the greater the growth rate.

The nucleic acids data for the 1990 YOY suggest that recent growth preceding capture was less than for the 1989 YOY. If it turns out that the 1990 YOY were younger than those collected in 1989, as might be suggested by the length and weight data, then recent growth was even less than would be indicated from RNA/DNA assuming YOY were of the same age.

At this point, nucleic acids data can only be used for comparative purposes. These data will provide greater utility when controlled laboratory studies, which determine the quantitative relationships between feeding (and food quality), RNA/DNA and growth rate for specific age ranges, are completed. However, based on published data for other fish species, the RNA/DNA for juvenile yellowtail rockfish obtained in both 1989 and 1990 is quite high and indicative of recent rapid growth. (B. MacFarlane, FTS 556-0565)

Adult Yellowtail Rockfish Stomach Analyses Near Completion

The condition and reproduction of yellowtail rockfish from Cordell Bank for the spawning year 1989/90 and the subsequent months into 1990 appear to be reduced from that observed in previous years. As part of an attempt to explain the lower fat reserves in the adults, the total weight of food (preserved wet weight of gut contents) and the relative digestive state of the food are being determined. In addition, the species composition of food in terms of numbers and weights of each species or taxon is being determined. Results to date show that a considerable variety of food species has been consumed by adult yellowtail rockfish at Cordell Bank over the past year.

The major prey species, in order of frequency of occurrence, are: the euphausiids (*Euphausia pacifica, Thysanoessa spinifera*), the salps (*Salpa fusiformis*), the pteropod (*Limacina helicina*) and adult, juvenile and larval squid (*Loligo opalescens*). Other species of salps and myctophid fish and juvenile octopus are also frequently observed. Analyses are incomplete, but the quantity of euphausiids in stomachs of yellowtail rockfish appeared to be much lower in the 1989/90 spawning year and this spring, than in previous years. (J. Whipple, FTS 556-0565)

GROUNDFISH COMMUNITIES INVESTIGATION

Natural Mortality of Juvenile Blue Rockfish Appears Density Dependent

The natural mortality rate of first-year juvenile blue rockfish is greater when there are more of them present. This has been evident to the Groundfish Communities Investigation for some time, based on their studies of trophic relations among coastal fishes. These studies have found that certain predators, for example the greenling, *Hexagrammos decagrammus*, feed heavily on juvenile blue rockfish when these prey are numerous, but show no interest in them when they are scarce. That juvenile blue rockfish of stronger year classes experience an increased natural mortality rate, is also the conclusion drawn by Fishery Biologists Pete Adams and Dan Howard from analysis of underwater counts made from 1985 to 1988 at one site on the Mendocino coast (Figure 1). Using data from 1986, a year of relatively weak recruitment, and 1987, a year of relatively strong recruitment, Adams and Howard have developed a model that demonstrates this relationship (Figure 2). The model incorporates differences between these years in numbers of individuals

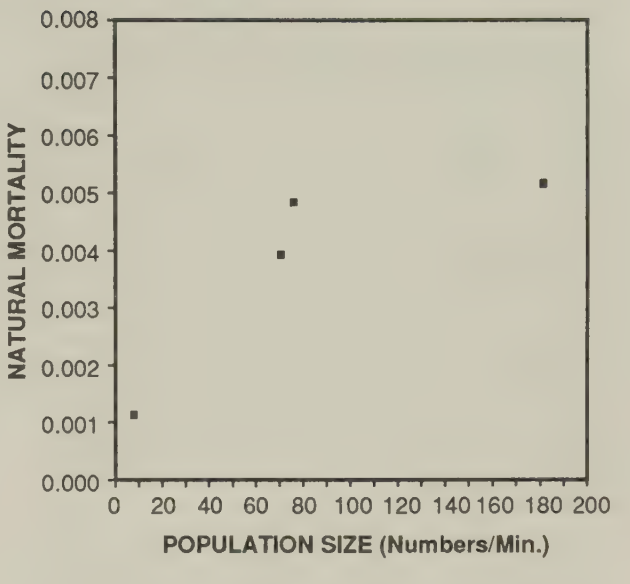

Figure 1. Average number of first-year juvenile blue rockfish counted per minute plotted against natural mortality rate (day^{-1}) estimates for 4 years (1985 to 1988) at Seal Cove, Mendocino County.

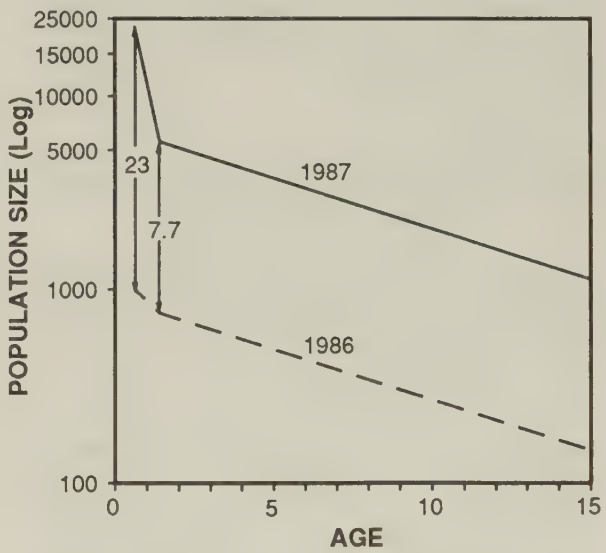

Figure 2. Model of effect of density-dependent mortality on numbers of blue rockfish of two year classes over time.

counted/min during August (1986/1987 ratio = 1/23) and in estimates of natural mortality rate during the period August to April (0.001 day^{-1} in 1986 and 0.005 day^{-1} in 1987, as calculated from counts over those months). During that time the ratio of individuals counted is seen to drop from 1/23 in August to 1/7.7 the following April. Because studies have shown that the differential

predation is concentrated on individuals in their first year, the model assumes that after April and to age 15 years, the fish of both year classes experience the same rate of natural mortality. This is taken to be 0.0004 day^{-1}, which is derived from the annual mortality rate of 0.15 that is commonly used for adult rockfishes in management studies.

Thus, density-dependent predation would seem to act as a buffer that reduces variation in year-class strength. The 1/7.7 ratio noted after the first-year mortality is consistent with differences in year classes among adults of other rockfish species. Although data for adult blue rockfish are unavailable, a ratio of 1/6.5 has been observed, representing the extremes in numbers of adult widow rockfish of different year classes.

Two cautions are to be considered in assessing this material. First, the confidence limits around the mortality regression are large to the extent that only extreme differences in year-class strength (greater than are considered here) can be expected to show statistical significance. Second, it has been found that trends in population parameters apparent in short time series may not be apparent over longer periods. Both of these cautions point to the need for more extended study. (P. Adams, FTS 556-0568)

INFORMATION TECHNOLOGY SERVICES

RFP for IT-95 System Mailed to Vendors

Years of effort expended by the NMFS regional field staff and Headquarters staff culminated on August 31 when the Request for Proposal (RFP) for the IT-95 system was mailed to 230 prospective vendors. A pre-proposal conference for interested vendors is scheduled for September 26 in Silver Spring Metro Center 2, Maryland. Upon payment of $200, the NOAA contracting officer will provide benchmark packages to requesting vendors. Proposals are due at the NOAA Procurement Office by 3:00 p.m. on October 15.

Following this closing date, the evaluation of each proposal begins. The technical score sheets for evaluating the solicitations were developed by the benchmark committee. A staff member from each regional site is represented on this committee. Because of Roger Hewitt's commitments in the Antarctic Program, Jerry Hornof was designated the new committee member representing the Southwest regional area.

To perform the evaluation review, NMFS appointed members to the Source Selection Advisory Board (SSAB). The board voting members are Chairperson Hoyt Wheeland, Senior Manager at NMFS Headquarters Darrell Tidwell, NOAA OAO IT coordinator and the Regional Data Base Administrators Eugene Heyerdahl (NEC), Mary Anne Treadway (SEC), Ted Rodgers (NWAC) and Dorothy Roll (SWC). The non-voting members are Mark Langstein (DOC General Counsel Office) and Meredith Beeg (NOAA contracting specialist). Assisting the SSAB are the Business Advisory Committee (BAC) and the Technical Advisory Committee (TAC), consisting of the benchmark team members. The BAC members are Meredith Beeg, Eugene Heyerdahl (NEC) and Howard Hockman (OMB).

The TAC member are Michael Fraser, IT-95 project manager at NMFS Headquarters, Richard Schween (HQ), James Sargent (NEC), Charles Krouse (SEC), Robert Reimann (NWAC), Frank Kikuchi (NWAC) and Jerry Hornof (SWC). (D. Roll, FTS 893-7057)

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Published

Balazs, G. H. 1990. Health advisory for fibropapilloma disease. Mar. Turtle Newsl. 49:27.

Boehlert, G. W. 1989. Ecology of tropical oceans by Alan R. Longhurst and D. Pauly. Am. Sci., Book Review 77:496-497.

Boehlert, G. W. 1990. Bronze medals awarded to NOAA scientists. Hawaii Fish. News 15(8):19.

Boehlert, G. W. 1990. Honolulu hosts cooperative studies on tuna. Hawaii Fish. News 15(7):16.

Boehlert, G. W., M. M. Yoklavich, and D. B. Chelton. 1989. Time series of growth in the genus *Sebastes* from the Northeast Pacific Ocean. Fish. Bull., U.S. 87(4):791-806.

Marine fish populations respond to their physical and biotic environment in complex ways. While direct studies may discern short-term responses at the individual level, time series are needed to describe or predict the population level response to environmental variation or cycles. We present an ageing technique that extracts historical growth information from

otoliths through sectioning and careful measurement to establish time series of growth. Otoliths of two long-lived species, *Sebastes pinniger* and *S. diploproa*, were collected off the west coast of North America in 1977-1984. Fish ages ranged from 1 to 86 years; corresponding birth dates were as early as 1896. Otolith measurements allow description of growth at ages 1 through 6 for several decades of this century. Although the technique has certain limitations, we note significant interannual variability in growth and interpret its relationship to the species' environment. Within species, coherence in growth among age groups was not always evident; first year growth in *S. diploproa* was particularly different from growth in other years. For both species, growth responses to environmental factors were not clear; the dominant signal in the time series appears to be increased growth rates after about 1970. We interpret this signal to be related to density-dependent factors (most likely prey availability) associated with stocks depleted by fishing pressure.

Everson, A. R., H. A. Williams, and B. M. Ito. 1989. Maturation and reproduction in two Hawaiian eteline snappers, uku, *Aprion virescens*, and onaga, *Etelis coruscans*. Fish. Bull., U.S. 87(4):877-888.

Size at sexual maturity, spawning season, and pattern of egg release were determined for two of Hawaii's commercially important snapper species, uku, *Aprion virescens*, and onaga, *Etelis coruscans*. Sexual maturity of females was assessed by macroscopic and microscopic (oocyte measurement, histology) techniques and gonosomatic indexes. Interspecific differences were noted in many aspects of the reproductive biology. Both species had protracted spawning seasons; uku spawned in May-October while onaga spawned in June-November. Size at sexual maturity of females was 425-475 mm fork length (FL) for uku and 675-725 mm FL for onaga. Both species were determined to be multiple spawners, although the number of batches spawned per season could not be established.

Fiedler, Paul C. and R. Michael Laurs. 1990. Variability of the Columbia River plume observed in visible and infrared satellite imagery. Int. J. Remote Sensing 11(6):999-1010.

Variability of the Columbia River plume in coastal waters off the northwestern United States, 1979-1985, was observed in sea surface temperature and phytoplankton pigment images derived from Advanced Very High Resolution Radiometer and Coastal Zone Colour Scanner data. The orientation, shape, intensity and relative temperature of the plume vary in response to coastal winds and wind-driven surface currents. From October to April, plume water is oriented northward along the coast. Following the spring transition in April or May, the plume is oriented southward, either adjacent to the coast or offshore. Transition between the winter and summer forms can be observed in the satellite imagery. Brief reversals of the prevailing seasonal winds cause rapid changes in the orientation and shape of the plume. Remote sensing of the Columbia River plume offers valuable information for oceanographic studies and fisheries management in the region. Derivation of an appropriate visible-infrared signature for plume waters and tracking of tidal pulses in the plume is suggested as a promising direction for future research.

Herrick, Samuel F., Jr. 1990. On measuring fishing fleet productivity: development and demonstration of an analytical framework. Fish. Bull., U.S. 88:85-94.

This study develops and demonstrates a framework for measuring changes in the total-factor productivity of fishing fleets operating in common-property, open-access fisheries. This approach is distinguished from previous efforts to measure productivity growth in fisheries by our explicit treatment of the fishery resource as a constraint on production and by the incorporation of recent advances in productivity measurement that take into account variations in the degree of capacity utilization in an industry. The approach is developed in sufficient detail for the non-economist fishery analyst to follow and implement. The empirical analysis of total-factor productivity growth in the U.S. tropical tuna fleet reveals that this approach eliminates a significant amount of bias in fleet productivity measures which is otherwise introduced when using traditional methods of productivity analysis.

Holt, Rennie S. and Stephanie N. Sexton. 1990. Monitoring trends in dolphin abundance in the eastern tropical Pacific using research vessels over a long sampling period: analyses of 1986 data, the first year. Fish. Bull., U.S. 88:105-111.

During 1986, the National Marine Fisheries Service began conducting long-term research vessel surveys to determine trends in population size of dolphin stocks taken incidentally by tuna purse seiners in the eastern tropical Pacific. Line transect methodology was used by observers aboard two vessels for 120 days each. We assumed the variability associated with the abundance estimates would be relatively constant during the sampling period and investigated (1) annual changes in population size of the northern offshore spotted stock that could be detected within a 5-year (six survey) sampling period, and (2) the number of years required to detect a 10% annual decline with and error levels of 10%. The abundance estimate of the northern offshore spotted dolphin stock using the first year's data was 929,000 animals. After 5 years, a minimum 17.6% annual decline could be detected during which 62% of the stock would decrease. A 10% annual decline can be detected in a minimum of 8 years. Data from subsequent surveys will be investigated that may improve our ability to detect smaller annual declines.

MacFarlane, R. Bruce, H. Rodger Harvey, Michael J. Bowers and John S. Patton. 1990. Serum lipoproteins in striped bass (*Morone saxatilis*): effects of starvation. Can. J. Fish. Aquat. Sci. 47:739-745.

Withholding food for 4 weeks resulted in more extensive alterations within serum lipoprotein classes in striped bass (*Morone saxatilis*) than were evident in serum total lipids where only a decrease in triglycerides was significant. Total serum lipoprotein concentrations were about 3300 mg/dL in both fed and starved fish; however, high density lipoproteins (HDL) increased and very low density lipoproteins (VLDL) decreased significantly in the starved group. Quantitatively, the greatest changes in VLDL, the primary transporter of triglycerides, were declines in triglycerides and cholesterol esters. Within low density lipoproteins, triglycerides and phospholipids decreased. The HDL composition was affected least by starvation. Phospholipids were the dominant lipid in HDL and increased from 479.1 mg/dL in fed to 670.2 mg/dL in starved fish. The apoproteins of each lipoprotein class changed little qualitatively due to starvation. Our results reflect the importance of maintaining high levels of lipoproteins as a transport system for lipids from storage depots to depleted tissues permitting survival during prolonged periods of starvation that are often encountered by fish during colder months and during spawning migrations. Furthermore, during starvation HDL appears to assume increased significance as a vehicle for the transport of structural lipids to maintain tissue integrity.

Parrish, Frank A. 1989. Identification of habitat of juvenile snappers in Hawaii. Fish. Bull, U.S. 87(4):1001-1005.

Pitman, Robert L. and Lisa T. Ballance. 1990. Daytime feeding by Leach's storm-petrel on a midwater fish in the eastern tropical Pacific. The Condor 92:524-527.

Polovina, Jeffrey J. 1990. Application of yield-per-recruit and surplus production models to fishery enhancement through juvenile releases, pp. 29-33. *In* Albert K. Sparks (ed.), Marine farming and enhancement. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 85.

Ratty, Frank J., R. Michael Laurs and Raymond M. Kelly. 1990. Gonad morphology, histology, and spermatogenesis in South Pacific albacore tuna *Thunnus alalunga* (Scombridae). Fish. Bull., U.S. 88:207-216.

Smith, Susan E. and Norman J. Abramson. 1990. Leopard shark *Triakis semifasciata* distribution, mortality rate, yield and stock replenishment estimates based on a tagging study in San Francisco Bay. Fish. Bull., U.S. 88:371-381.

Leopard shark tag recovery data, obtained from a 1979-88 study in San Francisco Bay, were analyzed to determine temporal and geographic distribution of the tagged population. Virtual population analysis of the tag recovery data was used to derive fishing mortality rates, which in turn were used to obtain yield- per-recruit and stock replacement values, and to estimate the effect of management by size limit on stock replenishment and yield per recruit. Of the tagged population, 11% was recovered by sport anglers and commercial fishermen, and the distribution of recoveries indicates that leopard sharks are mostly resident in San Francisco Bay, although a portion of the population moves out of the Bay during fall and winter. An unusually high number of recaptures was made in 1983, a year of El Niño conditions and high river run-off. After obtaining mortality, yield, and stock replacement values, it was proposed that a viable management strategy for the San Francisco Bay leopard shark would be a size limit of 100 cm or 40 inches to ensure maintenance of the stock and provide a yield per recruit not too far below a maximum.

Thomas, J. A., P. W. B. Moore, P. E. Nachtigall, and W. G. Gilmartin. 1990. A new sound from a stranded pygmy sperm whale. Aquat. Mammal. 16.1:28-30.

Uchiyama, James H. and Jeffrey D. Sampaga. 1990. Age estimation and composition of pelagic armorhead *Pseudopentaceros wheeleri* from the Hancock Seamounts. Fish. Bull., U.S. 88:217- 222.

Wilson, C. D., and G. W. Boehlert. 1990. Acoustic measurement of micronekton distribution over Southeast Hancock Seamount, central Pacific Ocean. *In* S. P. Singal (ed.) Acoustic remote sensing of the atmosphere and oceans, p. 222-229. Tata-McGraw Hill Publ., New Delhi.

Acoustic detection of scattering layers over certain seamounts demonstrates significant diet variations that suggest changes in biological activity. We describe the behavior of these acoustic scattering layers over the Southeast Hancock Seamount in the central Pacific Ocean in 1985-88. Ground truth provided by sampling with midwater trawls provides a description of the organisms responsible for this scattering, but avoidance of the trawls by larger organisms may bias these results in certain circumstances. The spatial distribution of micronekton, as revealed by analysis of acoustic data, may differ from night to night; preliminary acoustic Doppler current profiler data indicate that ocean currents affect these distributions. The high density of the scattering layers may also bias acoustic measurements of ocean currents.

Approved by Science and Research Director, SWR

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tion in the Canadian Journal of Fisheries and Aquatic Sciences.

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Cranmore, Georgia. 1990. Status report on marine mammals involved in commercial fisheries. SWFC Admin. Rep., La Jolla, LJ- 90-19, 136 p.

Hohn, Aleta A. and Scott R. Benson. 1990. Bioacoustics of odontocets in the ETP: Project description, preliminary results, and recommendations for future work. SWFSC Admin. Rep., La Jolla, LJ-90-23.

Jacobson, Larry D. and Nancy C. H. Lo. 1990. Spawning biomass of the northern anchovy in 1990. SWFSC Admin. Rep., La Jolla, LJ- 90-20, 30 p.

Kawamoto, Kurt. E. and Samuel G. Pooley 1990. Bottomfish fishery in the Northwestern Hawaiian Islands, 1989. SWFSC Admin. Rep., Honolulu, H-90-12, 18 p.

Kramer, Sharon Hendrix. 1990. Habitat specificity and ontogenetic movements of juvenile California halibut, *Paralichthys californicus*, and other flatfishes in shallow waters of southern California. SWFSC Admin. Rep., La Jolla, LJ-90- 22.

Le Boeuf, Burney J. and Patricia Morris. 1990. Ground censuses of steller sea lions at Ano Nuevo Island. SWFSC Admin. Rep., La Jolla, LJ-90-25C, 7 p.

Moore, Sue. 1990. Spotted dolphin bioacoustics. SWFSC Admin. Rep., La Jolla, LJ-90-24C.

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